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Structural characteristics of expansively strained lanthanum deficient $La_{1-x}MnO_3$ films as a function of stoichiometry

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Beamline(s): X14A

Introduction: The $La_{1-x}A_xMnO_3$ systems may be modified by lanthanum substitution with A^{+2}, where proper substitution produces a large range of physical phenomena, including colossal magnetoresistance. The introduction of holes in Mn of the Mn^{3+} $t^3_{2g}e^1_g$ configuration is attributed for the allowance of ferromagnetic double-exchange in these materials, which is heavily correlated with the cation size augmenting the structure of the lattice. Lanthanum deficiency, rather than lanthanum replacement, has been found to also exhibit similar phenomena. The $La_{1-x}MnO_3$ system is especially attractive due to it's chemical simplicity. T_c values have been measured to values up to 270K [1, 2, 3, 4].

Methods and Materials: Epitaxial $La_{1-x}Mn_{1-z}O_{3-\delta}$ films were grown on (0 0 1) $SrTiO_3$ substrates via metalorganic chemical vapor deposition, with x values of 0.17, 0.10, 0.04, -0.03, and -0.09. The x=1.03 and 1.09 films echibit Mn deficiency. Synchrotron x-ray diffraction of the thin films were conducted at 8keV.

Results: The films were found to be (0 0 l) oriented as described by a simple cubic lattice. Film peaks were surveyed with respect to the (004), (006), (008), (220), (202), (220), and (-220) reflections of the substrate. Phi-scans were carried out at the (202) direction of the substrate sitting at the film peak parameters. These films are found to be c-axis oriented on the substrate. Measurements out-of-plane have found a trend towards decreased c-parameter and phi scans show an increase of long-range distortion for lower lanthanum content. Additional peaks have been found along the c-axis direction for films with x= -0.03 and -0.09. In-plane measurements find that there are at least two phases in all the films except that of the highest lanthanum content film. More in depth measurements were conducted during October 2002 and November 2002, for higher resolution and a more complete set of diffraction data.

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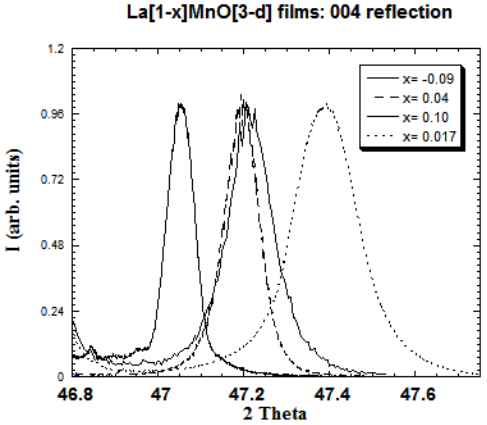

Figure 1. (004) reflection for $La_{1-x}Mn_{1-z}O_{3-\delta}$ films, normalized for comparison in position. The substrate peak lies at 46.718 degrees 2□.